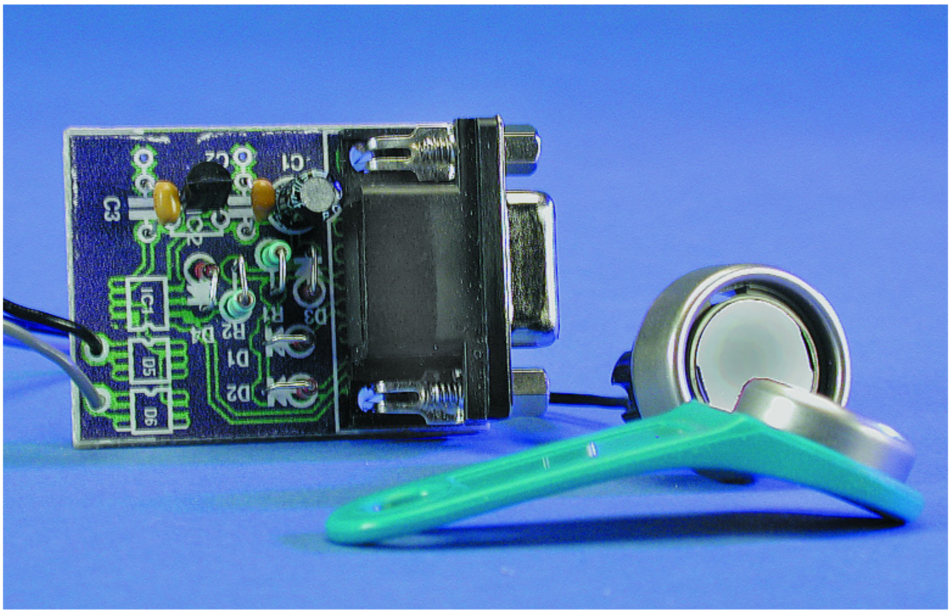
Serial Interface for Dallas 1-Wire Bus

simple to operate from within Windows

By Luc Lemmens

The 1-Wire devices from Dallas Semiconductor are components that via a simple serial connection can be connected to each other, a circuit or a computer. The RS232-interface described here makes the connection to a PC very straightforward. In addition, Dallas supplies the necessary software free of charge.



The 1-Wire series from Dallas already has received attention on earlier occasions in this magazine, such as the E-key project in November 2000 and the 1-Wire Spy in February 2001. In those projects the communication between the 1-wire bus and the PC was controlled by a microcontroller which was specifically programmed for this purpose. Dallas itself also manufactures ICs that deal with interfacing to microcontrollers or PCs. Drivers, evaluation and development software are available for free and may be downloaded from the Dallas web site. This clears most of the obstacles in making a beginning with these devices. This 1-Wire Software Developers Kit (SDK) for Windows Me, 2000, 98, 95, NT 4.00 en NT 3.51 contains programming examples in C, C++, Pascal (Borland Delphi), Microsoft Access and Microsoft Visual Basic. Development tools for 16-bit applications (Windows 3.1 and DOS) are also still available.

New components

The number of different 1-Wire components is quite extensive. In previous issues of *Elektor Electronics* most of the attention was directed towards the so-called iButtons. These are components that are housed in what resembles a sizeable button cell. But there are also components in that range, such as digital potentiometers, temperature sensors, clocks, switches, A/D converters, electronic IDs and memories that are available in a TO-92 package or SMD version. Every device has its own family code (depending on the type of device) and a unique serial number, which enables each device that is connected to the bus to be identified and addressed. **Table 1** shows an overview of the 1-Wire devices that are currently available.

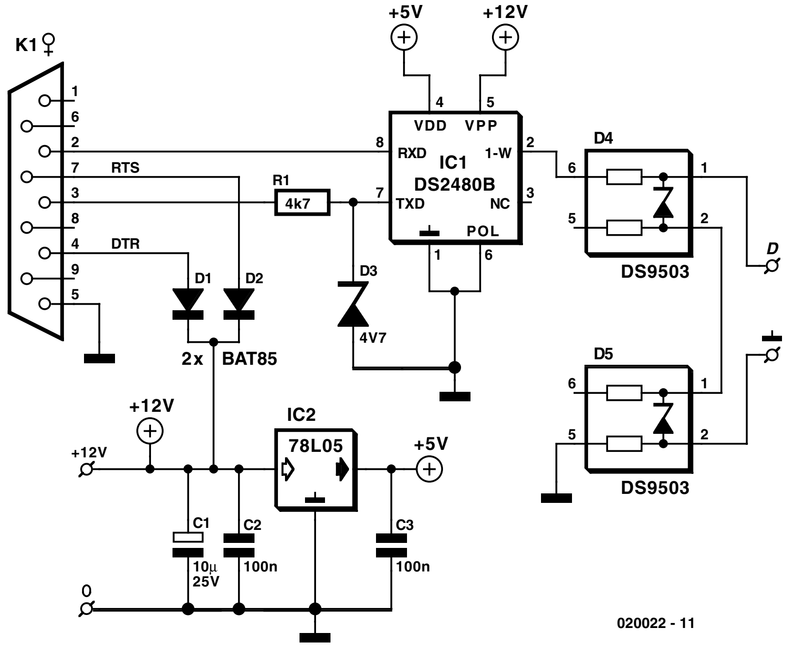


Figure 1. The interface circuit consists almost entirely of two Dallas ICs.

The 1-Wire bus makes it very easy to build a small network that, for example, can measure the temperature in different rooms in a building, or operate switches or light dimmers, etc.

The hardware is very simple: two wires provide power and communications. And Dallas has made available a complete software package on the Internet so that anyone can get started easily. Of course, the 1-Wire bus has to be connected to a PC somehow, but this is not an insurmountable problem, given the interface ICs that have been designed for this bus. In this article we present a serial RS232 interface, a USB interface is to follow soon.

The heart of the interface: the DS2480B

This IC is small with respect to its dimensions (SO-8 package), but large with reference to its capabilities and options. This

1-Wire-Device	Function	Memory
DS1820	Digital Thermometer	16 Bits EEPROM
DS18B20	Programmable Resolution Digital Thermometer	16 Bits EEPROM
DS18S20	High-Precision Digital Thermometer	16 Bits EEPROM
DS1821	Stand-alone Thermostat	2 bytes NV
DS1822	Programmable Resolution Digital Thermometer	No NV
DS2401	Silicon Serial Number	No additional memory
DS2404	EconoRAM Time Chip	4096 bits RAM
DS2404S-C01	Dual-Port Memory Plus Time	4096 bits RAM
DS2405	Addressable Switch	No additional memory
DS2406	Dual Addressable Switch	1024 Bits EPROM
DS2409	MicroLAN Coupler	No additional memory
DS2417	Time Chip with Interrupt	32-bit Real Time Clock Counter
DS2423	1-Wire RAM with Counters	4096 bits RAM
DS2430A	1-Wire EEPROM	256+64 bits EEPROM
DS2433	1-Wire EEPROM	4096 bits EEPROM
DS2434	Thermometer	32 byte EEPROM, 32 bytes SRAM
DS2435	Thermometer/Time-Temperature Histogram	32 bytes EEPROM, 32 bytes SRAM
DS2436	Thermometer, Voltage A/D	32 bytes EEPROM, 8 bytes SRAM
DS2437	Fuel Gauge, Voltage A/D, RealTime Clock, Temperature	40 bytes EEPROM
DS2438	Fuel Gauge, Voltage A/D, Elapsed Time, Temperature	40 bytes EEPROM
DS2450	1-Wire Quad A/D Converter	Status Control Memory Only
DS2480B	1-Wire Line Driver	Status Control Memory Only
DS2490	USB to 1-Wire Bridge	Chip Mode Control and I/O FIFOs
DS2502	Add-only Memory	1024 Bits EPROM
DS2502-UNW	UniqueWare	1024 Bits EPROM
DS2502-E64	IEEE EUI-64 Node Address Chip	256 bits pre-programmed, 768 bits user-programmable
DS2505	Add-only Memory	16,384 Bits EPROM
DS2505-UNW	UniqueWare	16,384 Bits EPROM
DS2506	Add-only Memory	65,536 Bits EPROM
DS2506-UNW	UniqueWare	65,536 Bits EPROM
DS2890	1-Wire Digital Potentiometer	Feature and Control Memory
DS9502	ESD Protection Diode	–
DS9503	ESD Protection Diode with Resistors	–

Table 1. Overview of al 1-Wire devices currently available.

makes it quite a complicated component, but because of the software made available by Dallas we need not concern ourselves too much about the inner workings of this IC. Readers who would like to know exactly what happens inside the DS2480B can study the 30-page datasheet. In this article we make grateful use of the fact that we can treat this IC as a black box. We only need to concern ourselves with the 1-wire devices that are connected to the bus; how they communicate with the PC is of secondary interest.

Hardware

The serial interface between the PC and the 1-Wire bus does not require much, the DS2480B does all the work in co-operation with the driver that is part of the software. The entire schematic is shown in **Figure 1**, and this version is about as complex as possible. For more basic applications a number of parts can even be omitted.

Serial interface

The interface-IC communicates via the RxD and TxD lines of the RS232 port of the PC. As is well-know, according to the standard, a logic one corresponds to –12 V and a logic zero to +12 V, while the serial protocol at the microcontroller is usually +5 V and 0 V respectively. When pin 6 of the IC (POLarity) is connected to ground, the serial signals are inverted inside the DS2480B. The RS232-interface is as simple as passively clamping (R1 and D3) the signal on pin 7 (TxD). The resistor and zener diode ensure that the voltage on this pin is limited to the range of 0 to 4.7 V.

Most (but not all!) modern RS232 ports are quite happy to accept 0 V as a ‘1’ and +5 V as ‘0’. For this reason no additional hardware was added to make this signal conform to the standard (-12 V and +12 V respectively).

1-Wire bus

As the name implies, there is just one ‘wire’ from the DS2480B that deals with the communications on the bus. Most 1-Wire ICs may be powered directly from this bus. In addition, there are devices with a programmable memory (EPROM, Electrically Programmable ROM; note that these are OTP because they do not have windows) that require 12V programming pulses in order to store data. This programming voltage is available at the interface on the VPP-pin (pin 5) of the DS2480B and is automatically applied to the bus when a programming command has been issued.

Dallas Semiconductor explicitly warns users that, when programming, only a single EPROM device must be connected to the interface, with only a short length of wire. In addition, never execute programming commands on the bus if there are devices connected to it that do not contain an EEPROM. This could cause damage to the device or the DS2480B!

D4 and D5 provide ESD-protection (ElectroStatic Discharge) for the interface so that it cannot be damaged by electrostatic discharges from the 1-Wire bus. The DS9503 has a very fast internal diode with a zener voltage of about 7.5 V. The effect of the built-in 5 Ω resistors may be ignored during normal com-

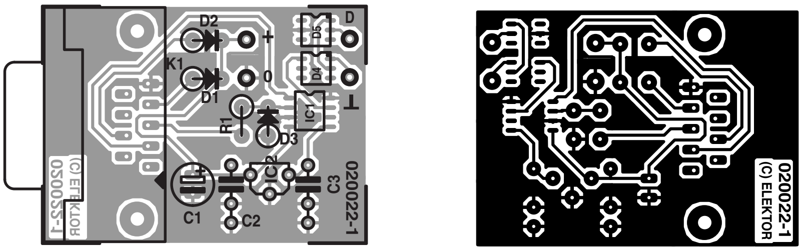


Figure 2. The PCB is not large since the ICs are in SMD packages. Be careful when soldering!

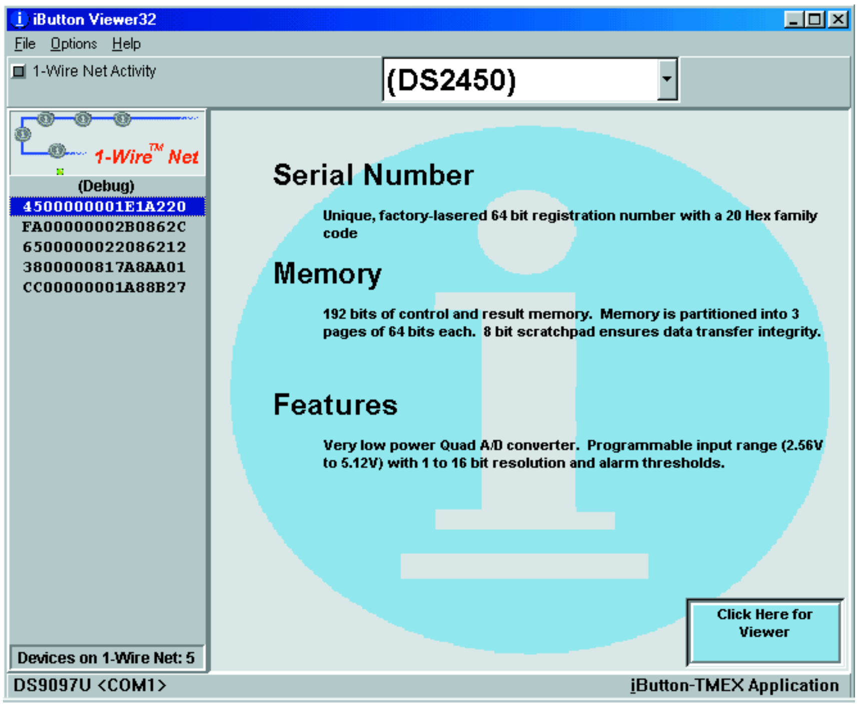
COMPONENTS LIST

Resistors:
R1 = 4kΩ7

Capacitors:
C1 = 10µF 25V radial
C2,C3 = 100nF

Semiconductors:
D1,D2 = BAT85
D3 = zener diode 4.7V 400 mW
D4,D5 = DS9503 (6-pin TSOC)
IC1 = DS2480BS (8-pin SOIC)
IC2 = 78L05

Miscellaneous:
K1 = 9-way sub-D- socket (female), angled pins, PCB mount
PCB, order code **020022-1** (see Readers Services pages)



☐ 1-Wire Net Activity

(DS2450)

(Debug)

```
4500000001E1A220
FA00000002B0862C
6500000022086212
3800000817A8AA01
CC00000001A88B27
```

Devices on 1-Wire Net: 5

Serial Number

Unique, factory-lasered 64 bit registration number with a 20 Hex family code

Memory

192 bits of control and result memory. Memory is partitioned into 3 pages of 64 bits each. 8 bit scratchpad ensures data transfer integrity.

Features

Very low power Quad A/D converter. Programmable input range (2.56V to 5.12V) with 1 to 16 bit resolution and alarm thresholds.

DS9097U <COM1>

iButton-TMEX Application

Figure 3. The main window of the iButton Viewer.

munications but form a high impedance with respect to the zener diode if a discharge occurs on the bus. This ensures that the discharge current flows through the diodes and not pin 2 of the interface IC. If the interface is not going to be used with EPROMs (which require 12 V programming pulses), the normal operating voltage on the bus will not exceed 5 V and D5 can be omitted. Pin 5 of D4 is then directly connected to the ground plane on the PCB and the ground connection of K2 to the anode (pin 2 of D4).

Power supply

The power supply can be obtained from the RS232 port, but that won't be sufficient for the memory devices in the 1-Wire bus that require a 12-V programming voltage. In order to program memories, an external regulated 12-V power supply is connected to K3. Just to be sure: take note of the warnings with respect to the programming of these memories mentioned earlier!

Under normal circumstances, the DTR and RTS can provide the power for the interface. When one of the lines is high (+12 V), there is sufficient current available for IC2 to provide a nicely regulated +5-V supply.

Construction and test

Figure 2 shows the printed circuit board layout that was designed for this interface.

The DS2480B and DS9503 are SMD-components and it is recommended that these parts are fitted first, on the copper side of the PCB. Pay close attention to the marking of pin 1 (a notch). Put a small amount of solder on one corner pad, then place the IC correctly on its footprint and solder this pin first. Proceed to solder the corner pin diagonally opposite. Now carefully check that all the other pins are properly aligned with their corresponding solder pads, before soldering the remaining pins. Excessive solder can be removed with solder wick.

Continue by fitting the resistors and diodes vertically on the component side of the PCB and, last but not least, the voltage regulator IC2, the capacitors and the connectors.

When you are finished, carefully inspect your work. Pay particular attention to possible short-circuits between the pins of the SMD devices.

Before we test the hardware we first download the iButton Viewer and TMEX-drivers from

www.ibutton.com/software/tmex/index.html

Currently version 3.20 is the most recent. The file TM320_32.EXE installs the drivers and the software, and when completed, immediately starts up the iButton Viewer. This program will first go looking for the 1-wire interface.

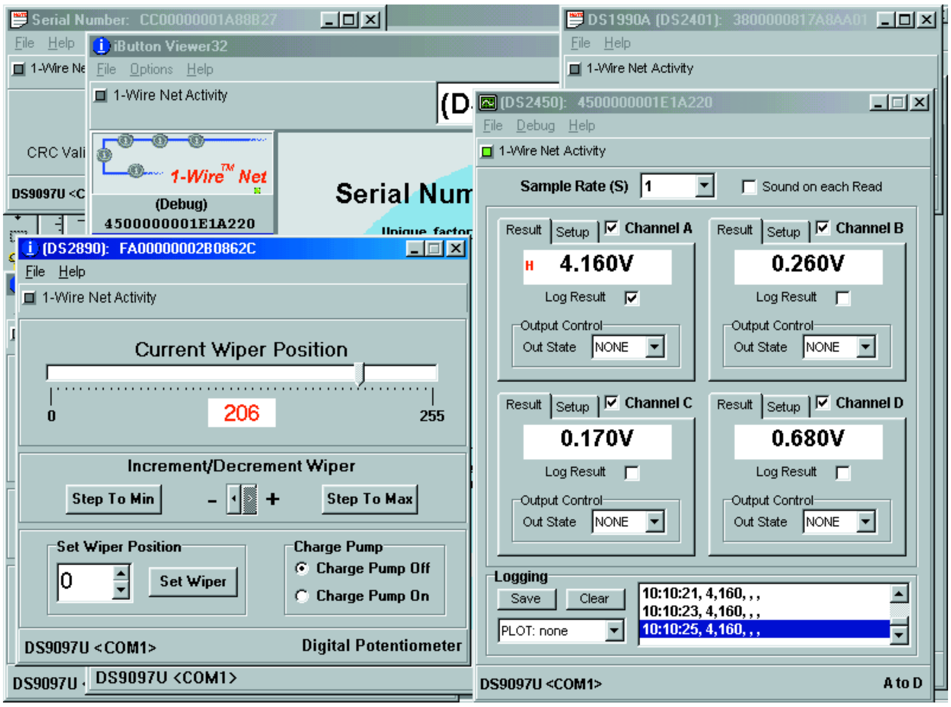
Connect the circuit with a normal 9-wire serial cable (NOT a null modem cable!) to an available COM port on the PC. The external power supply on K3 is not required and no devices are connected to the 1-Wire bus yet. If everything is correct, our interface will be found after clicking the Auto-Detect button. The setup program will close and the iButton viewer has to be restarted. An error message will appear immediately if the program is unable to communicate with the interface. If this is the case, the fault is almost certainly with the hardware. Once again check your soldering, the orientation of the ICs, electrolytic capacitors and diodes.

If everything goes as desired, the software will indicate a DS9097U adapter attached to the COM port; this is the interface that is built with a DS2480. At this point the communication between the PC and the interface is working properly. We can now proceed to the 1-wire bus, which is what started all of this in the first place.

Devices on the 1-Wire bus

Now that we have a fully functioning interface it is time to connect one or more devices to the 1-Wire bus. Read the corresponding data sheets thoroughly. Some devices can be directly connected with two wires to K2 of the interface, but others may require external components (a crystal, for example, with clock-IC DS2417) or their own stabilised power supply.

Those of you who don't like programming can get started immediately with the iButton Viewer. This program automatically shows which devices are present on the 1-Wire bus. **Figure 3** shows the main window of the viewer. In the left column are the unique identification numbers of the five devices that have been found on the bus. On the right is a brief description of the device that has been highlighted on the left, in this case a DS2450 (a 4-channel A/D converter).

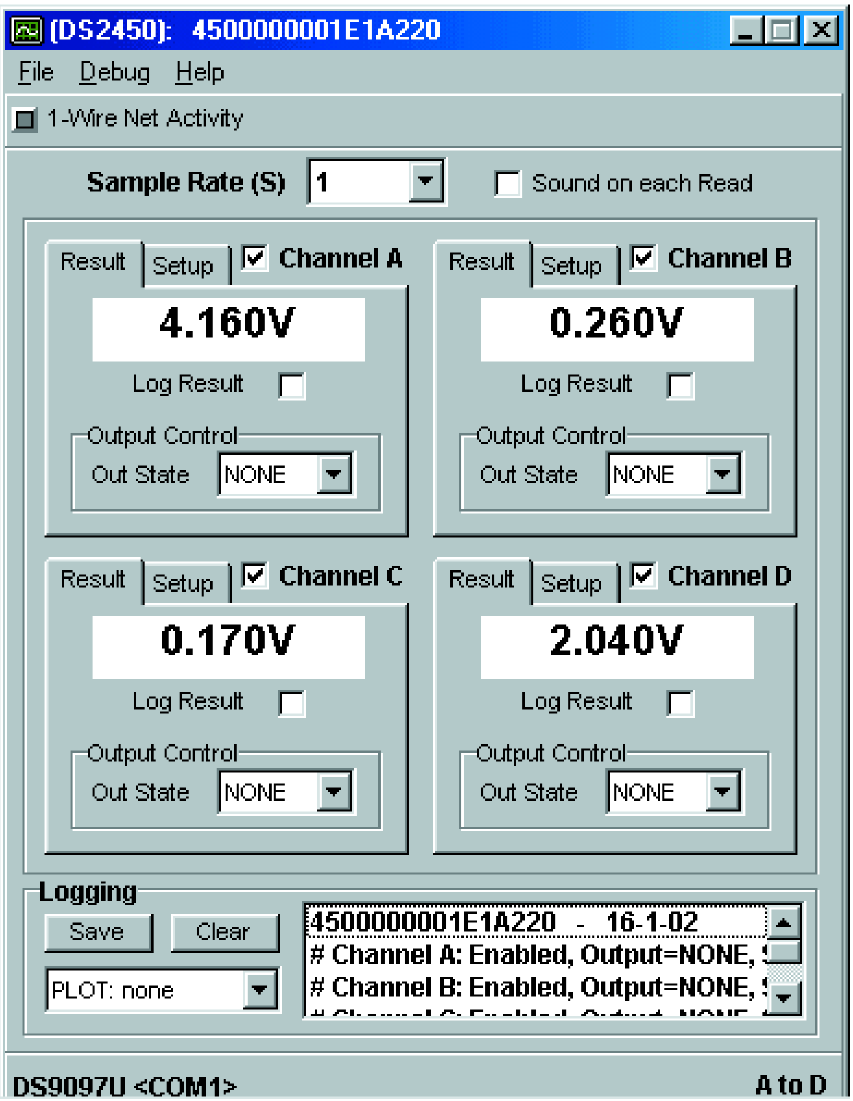


Serial Number: CC00000001A88B27
iButton Viewer32
4500000001E1A220
Serial Num
DS9097U <C
(DS2890): FA00000002B0862C
Current Wiper Position
0 206 255
Increment/Decrement Wiper
Set Wiper Position 0
Charge Pump
● Charge Pump Off
○ Charge Pump On
DS9097U <COM1> Digital Potentiometer
DS9097U <COM1>
DS1990A (DS2401): 3800000817A8AA01
(DS2450): 4500000001E1A220
Sample Rate (S) 1 ☐ Sound on each Read
☑ Channel A 4.160V Log Result ☑ Output Control Out State NONE
☑ Channel B 0.260V Log Result ☐ Output Control Out State NONE
☑ Channel C 0.170V Log Result ☐ Output Control Out State NONE
☑ Channel D 0.680V Log Result ☐ Output Control Out State NONE
Logging PLOT: none
10:10:21, 4,160, , ,
10:10:23, 4,160, , ,
10:10:25, 4,160, , ,
DS9097U <COM1> A to D

Clicking the button 'Click Here for Viewer' opens a window which displays the four measurement values and various settings for this IC (refer to **Figure 4**). The settings can be altered. For example, the time interval between two measurements can be changed, one or more channels can be turned on or off or the measuring range of a channel can be adjusted, etc.

It is also possible to open multiple views at once, so that several devices are displayed on the screen at the same time. In this way, it is easy to obtain an overview of the network and makes experimenting easy. One way is to interconnect different 1-Wire devices. For example, we can connect a 1-Wire potentiometer to one channel of the A/D-converter and observe the changing measurement result of this channel.

This is all very nice, and very entertaining to play with, and it may even be sufficient for simple applications, but the iButton Viewer does not allow several devices to be interconnected in software. If you would like to do more, such as automatically operate a switch connected to the bus when the measurement result on channel A of the A/D-converter exceeds a certain value, then you will have to program this yourself. The 1-Wire Software Developer's Kit (SDK), available from the Dallas web site, facilitates this.



(DS2450): 4500000001E1A220

☐ 1-Wire Net Activity

Sample Rate (S) 1

☐ Sound on each Read

☑ Channel A: 4.160V; Log Result ☐; Out State NONE

☑ Channel B: 0.260V; Log Result ☐; Out State NONE

☑ Channel C: 0.170V; Log Result ☐; Out State NONE

☑ Channel D: 2.040V; Log Result ☐; Out State NONE

PLOT: none

```
4500000001E1A220  -  16-1-02
# Channel A: Enabled, Output=NONE,
# Channel B: Enabled, Output=NONE,
```

DS9097U <COM1>   A to D

Figure 4. This window shows the four measurement results and various settings of the 4-channel A/D converter DS2450.

1-Wire SDK

This software package can be downloaded from the same page as the iButton Viewer. At the moment the most recent version is SDK V4.0 ALPHA. This contains, among other things, the documentation for the TMEX API (application program interface) and descriptions of the functions that can be called from within you own software to communicate with devices that are connected to the 1-Wire bus. It also contains drivers for the serial interface and USB on a PC and programming examples in Pascal, Delphi, C and Visual Basic. There is more than enough information and reading material to get you started with your own programming.

The 1-Wire bus in practice

Unfortunately, we cannot connect an unlimited number of 1-Wire devices to the interface that has been described in this article. Also, the physical layout of the total network, such as cable lengths and topology of the bus is limited in practice. As long as the interface and the devices connected to it are spread out over a workbench and the bus length is less than 1 meter or so, there will be no problems. But before you randomly start drilling holes and run wires through a house or other building, it is recommended that you first read application note AN148, 'Guidelines for Reliable 1-Wire Networks'. This contains a clear and thorough description of the rules that you have to adhere to, and which steps you can take, to ensure reliable communications across the network. This application note, which also contains additional information about the DS2480B, can be found with the other 1-Wire application notes.

(020022-1)

Internet addresses:

1-Wire SDK:

www.ibutton.com/software/tmex/

1-Wire application notes:

http://dbserv.maxim-ic.com/
an_prodline2.cfm?prodline=21